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PREFACE

"Conservation in Alberta, 1968" has been prepared by the Oil and Gas Conservation Board to acquaint members of the Legislative Assembly of Alberta and the public at large with the conservation of Alberta's oil and gas resources and with the role of the Board. The text has been written in a non-technical style without detailed statistics.

Included in the report are a discussion of some recent conservation problems, an outline of the responsibilities of the Board, and a brief review of the reserves and production of oil and gas and their by-products. The enhanced recovery of crude oil and the conservation of solution gas are also discussed. This edition includes two special sections, the first dealing with the New Proration Plan which became fully implemented in May, 1969, and the second describing the important features, and aspects of interest, of the Board's work in the field of Oil and Gas Statistics. The final section in the report briefly summarizes Board operations during 1968.

The more detailed publication "Report of the Operations of the Oil and Gas Conservation Board" will also be published for general distribution this year.

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COVER PICTURE: Our cover picture, courtesy of Great Plains Development Company of Canada, Ltd., is of a crude oil well and its battery of tanks in the Harmattan-Elkton Field, 55 miles north-west of Calgary. Light gravity oil is produced at a depth of 5,460 feet from the Rundle zone of Mississippian Age. The well is now part of Harmattan-Elkton Unit No. 1, operated by Canadian Superior Oil Ltd.

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CONSERVATION — SOME PROBLEMS AND SOLUTIONS

The finding and development of a new oil or gas play always raises new problems both for the industry and for government. When the solutions have been worked out, conservation is a frequent beneficiary. Alberta's new Rainbow-Zama area is no exception. The discovery in 1965 of oil and gas in the Muskeg and Keg River formations in the far north-western corner of Alberta introduced an unusual number of new factors to the oil industry in the Province. Some are of a temporary nature, but others will permanently shape future exploration, production and conservation.

Distance and Terrain

The Rainbow-Zama discovery established for Alberta a new record for difficulty of access — the combination of poor terrain and distance from service centers proved to be Alberta's worst for a major oil find. But this did not prevent the industry from finding oil reserves of over a billion barrels by the end of 1968, and from building two large crude oil pipe lines to handle its production, pumping over 90,000 barrels per day to market by year end. Solving the problems of accessibility led to development of new supply techniques and production methods, specially geared to the environment and designed to alleviate remote-area employment difficulties.

Finding

The Rainbow-Zama crude oil play has involved the discovery of hundreds of small pinnacle and atoll-shaped reefs in the Elk Point formation about a mile below the surface. Oil has also been discovered in less important zones which nature subsequently draped over the reef growths. The reefs vary widely in size, ranging from a few acres to several square miles in area and from a few feet to five hundred feet in oil zone thickness. A typical one is quite small — perhaps 50 to 80 acres in area and with about 150 to 200 feet of oil "pay" in its vertical section. This is a very small oil pool by almost any standard. The industry's exploration specialists were obliged to develop highly specific search techniques to find and delineate these illusive but frequently profitable structures. To their credit they have found over 250 so far, covering in all an area of only 25,000 acres — in an area of exploration of over 3,000,000 acres. The methods developed are now helping in the search for other new oil and gas pools.

Pool Access

Not only are the small reefs a challenge to those who search for them, but they also confront the production supervisor and the reservoir engineer with unique problems. A few of the pools have several wells completed in them, but on average the size of pool and the high cost of wells in this remote area preclude drilling more than one well per pool. This means that the only access to the pool is through a single steel tube having about the same diameter-to-length ratio as a human hair. The loss risk is high, and the technical problems many. With only one well, reservoir information is minimal and efforts to improve the production efficiency and recovery from the pool are sometimes based as much on conjecture as on fact. Also, it seems to be characteristic of the region that pressure in the oil zone declines more rapidly than in other parts of the Province, forewarning of declining production rates and poor oil recovery. All of these factors have impelled the use of special production techniques and the prompt study of methods of improving recovery.

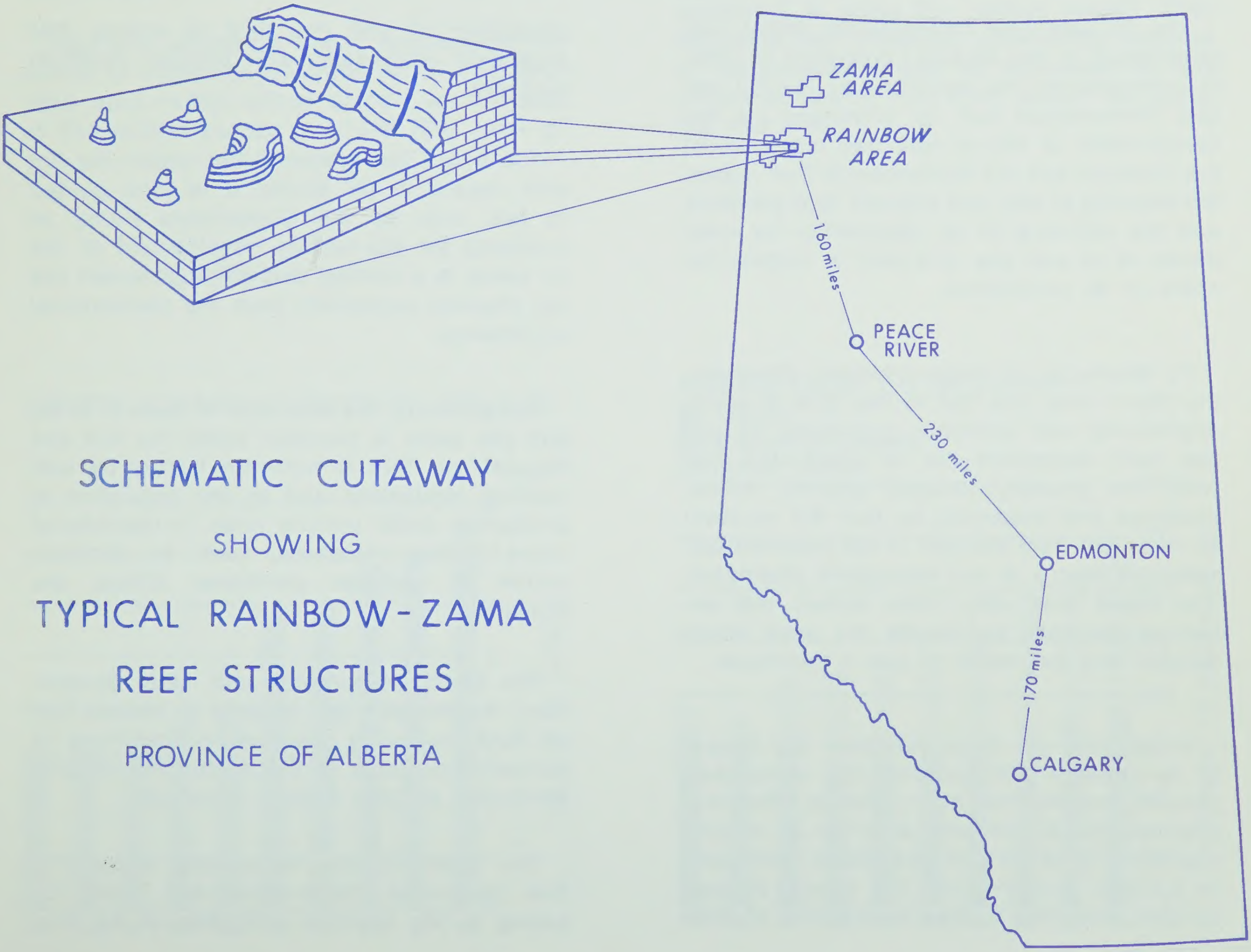
Gas Supply

Studies of the larger pools showed that many of the oil bearing reefs were generally good candidates for production by solvent flooding. A solvent flood, using a displacing fluid miscible with the oil, leaves no residual oil in its wake and will usually provide a substantial increase in oil recovery over any other known method. Consequently the Rainbow-Zama owners and the Board were both keenly interested in maximum use of this technique. However, solvent is most cheaply obtained as a by-product of the processing of natural gas, and the economical use of solvent requires that it also be driven through the reservoir by natural gas. There is a general shortage of gas in the Rainbow-Zama area, and distance precludes bringing it from areas where it is surplus.

Integrated Pools

One way of extending the benefits of solvent flooding in the face of the gas shortages appeared to be a revision in the normal system for concurrent sharing of production among the pools in the Province. With the agreement of the industry the Board in 1968 sought and obtained new legislation so that pools may be grouped or integrated if by so doing oil recovery may be improved. Thus an example of an integrated scheme would be one that would provide for the solvent flooding in sequence of several pools, re-using the gas from pool to pool. Production would be taken only from the pool or pools in which pressure was being efficiently maintained by a gas-driven solvent bank system.

Through adopting the idea of integrated schemes, the Province and the pool owners benefit by a gain in gas conservation, and by the extra oil conservation generated by the more efficient solvent flood. In addition, the increase in the expected recovery of crude oil from the pool entitles the pool owners to a higher production rate under Alberta's market



SCHEMATIC CUTAWAY

SHOWING

TYPICAL RAINBOW-ZAMA REEF STRUCTURES

PROVINCE OF ALBERTA

sharing plan. A very real incentive to initiate efficient oil recovery processes has been created.

Results

Two integrated schemes in the Rainbow-Zama area have so far been approved and put into operation. It is estimated that these will generate an extra four million barrels of oil over that obtainable by the same flood methods had they not been the integrated type. The results to this point have been modest, but positive. Other studies now under way are expected to lead to other integrated schemes and bring additional conservation gains.

The search for and production of oil along the Rainbow-Zama trend has brought innovations to the oil and gas picture in Alberta. The industry and the people of the Province are already reaping the benefits.

RESPONSIBILITIES OF THE BOARD

The Oil and Gas Conservation Board was established by the Alberta Legislature in 1938. In administering the provisions of The Oil and Gas Conservation Act, its objectives are the conservation of the oil and gas resources of the Province and the prevention of their waste, the ensuring of safe and efficient field practices and the affording of an opportunity for each owner of oil and gas in a pool to recover his share in its production.

To discharge its responsibilities effectively, the Board must see that in the light of sound engineering and economic principles, oil and gas field operations are so conducted that wells are properly located, spaced, drilled, equipped and produced, so that the recovery of oil or gas from the pool is not lessened and reservoir energy is not improperly dissipated. The Board must also make certain that enhanced recovery techniques are used where suitable and that waste of gas is minimized.

In carrying out these functions the Board, in co-operation with industry, has established specific regulations and policies. The Act provides the Board with authority to require operators to undertake operations necessary to improve conservation. The Board, through its staff, maintains a close surveillance of each producing oil and gas field to ensure that producing operations will provide optimum recovery.

The Board has similar duties under the Act with regard to oil sands. It is also guided in this area by the Government Policy of providing for the orderly development of the oil sands in a manner that will supplement but not displace production from the conventional oil industry.

Protection of the interests of owners in oil and gas pools is provided under the Act and Regulations. This is achieved largely by well spacing regulations and by the regulation of production under uniform rules. In exceptional cases further measures, such as common carrier or common purchaser orders, are available.

The Board co-operates with other Government departments and industry to ensure that oil field producing practices do not lead to excessive pollution or the destruction or contamination of other natural resources.

The Board is also responsible under The Gas Resources Preservation Act, 1956, for seeing to the effective utilization of the Province's gas resources. Applications for removal of gas or propane from Alberta are evaluated having regard to the present and future needs of the people within the Province, and permits are granted only for quantities surplus to these needs.

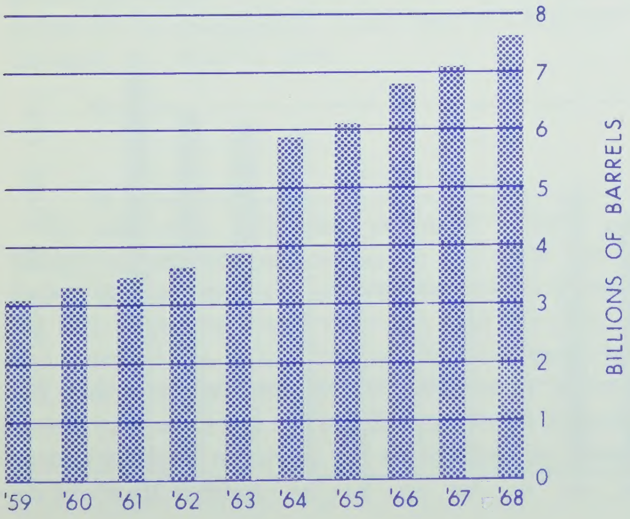
Since 1958, some special responsibilities in the old Turner Valley Field have been given to the Board by The Turner Valley Unit Operations Act. Because of the wide diversity of ownership in the Field, and to expedite plans for improving recovery from it, the Board was authorized to combine diverse holdings into a single unit operation if one or more owners requested it. Five units comprising the whole of the Turner Valley Rundle Pool have since been established.

PRODUCTION AND RESERVES

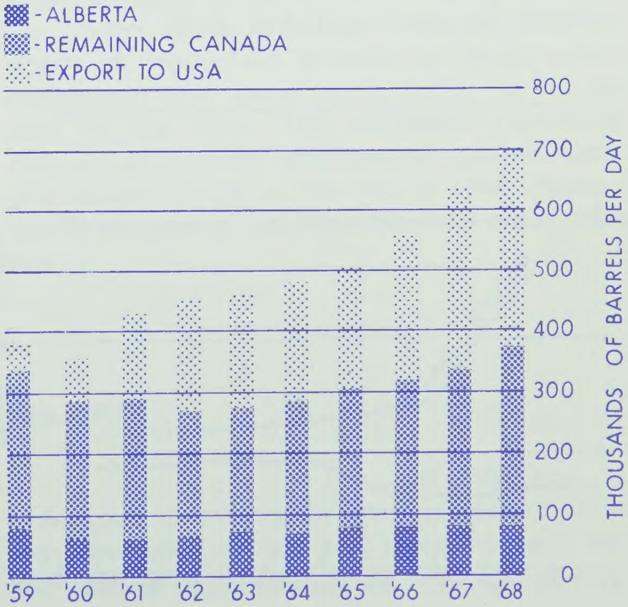
CRUDE OIL

Alberta's estimated initial recoverable reserves of conventional crude oil at year end 1968 were 10,340 million barrels, an increase of 754 million barrels over the 1967 level of 9,586 million barrels. The 1968 production amounted to some 251 million barrels. Consequently, the remaining recoverable reserves of conventional crude oil increased by 503 million barrels to total 7,632 million barrels at the year's end.

ALBERTA REMAINING CRUDE OIL RESERVES



ALBERTA CRUDE OIL DELIVERIES



Most of the increase to Alberta's initial recoverable reserves of conventional crude oil are attributable to reserve appreciation in previously discovered pools which resulted mainly from new enhanced recovery schemes and reappraisal and extensions to a number of pools. The Mitsue, Joarcam, Joffre, Swan Hills and Rainbow areas contributed a large share of the reserves added in 1968.

In 1968 Alberta's production of conventional crude oil averaged some 685,000 barrels per day, while production of synthetic crude oil from the Great Canadian Oil Sands Limited plant averaged about 16,000 barrels per day. Demand for Alberta's crude oil in 1968 increased by 11 per cent, while the total demand for Western Canadian crude oil rose by some 8 per cent. Hence, Alberta increased its share of the total market for Western Canadian oil during 1968.

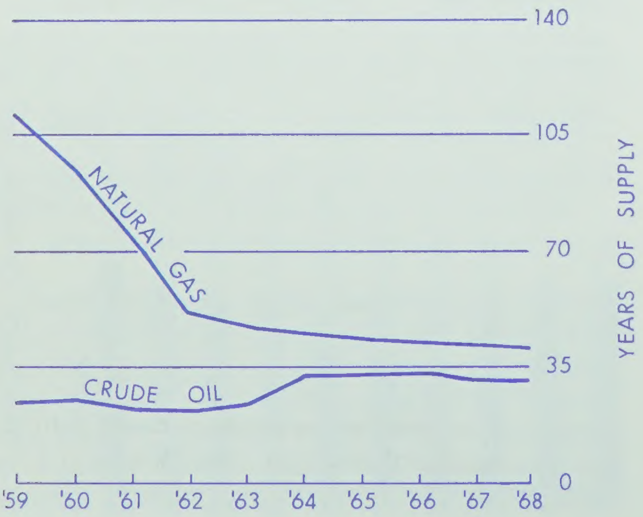
Shipments of Alberta oil to the United States in 1968 averaged 325,000 barrels per day, an increase of some 12 per cent or 35,000 barrels per day higher than in 1967. Most of the increase went to the north-central and north-eastern part of the States, since most of the market growth in the U.S. west coast has been absorbed by oil from Alaska's Cook Inlet. Canadian demand for Alberta's crude oil was 376,000 barrels per day, which is an increase of 34,000 barrels per day or some 10 per cent over the 1967 total. Ontario provided by far the largest portion of this.

Remaining recoverable reserves of Alberta's conventional crude oil were sufficient to provide for 30 years of production at the 1968 rate. The "years of supply" index of 30 shows a modest decline in the past two years, demonstrating that, while remaining reserves continue to increase, they are doing so at a lesser rate than the markets are expanding. The years of supply for Canada as a whole is some 22 years while for the United States it is approximately 10 years.

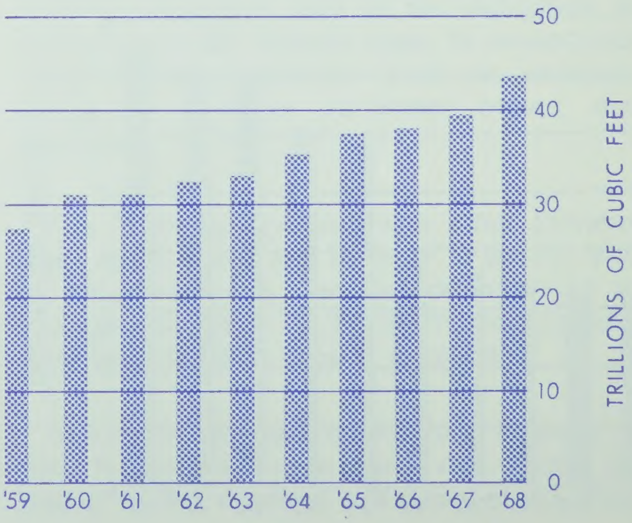
NATURAL GAS

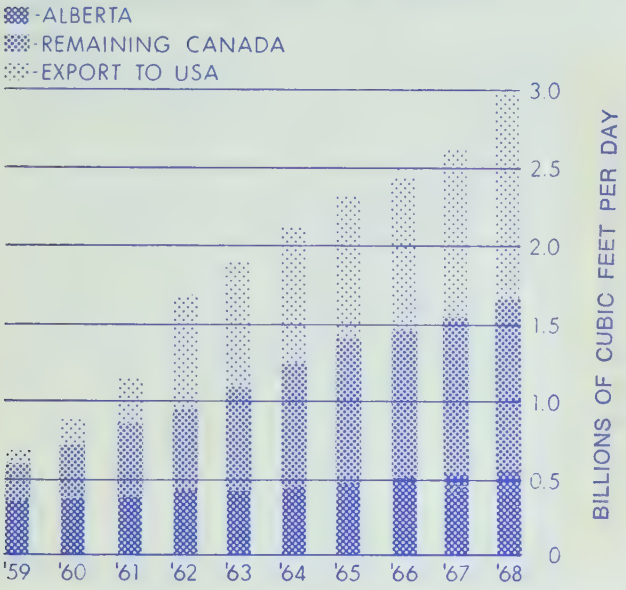
The initial reserves of natural gas at December 31, 1968 were estimated to be 51.8

YEARS OF SUPPLY OF ALBERTA CRUDE OIL AND NATURAL GAS



ALBERTA REMAINING NATURAL GAS RESERVES





ALBERTA NATURAL GAS DELIVERIES

trillion cubic feet, an increase of 4.8 trillion cubic feet in 1968 over 1967. Production of natural gas in 1968 amounted to 1.1 trillion cubic feet. Consequently, the remaining recoverable reserves increased by 3.7 trillion cubic feet to a total 43.4 trillion cubic feet at year end 1968.

Increased requirements for Alberta's natural gas in the United States during 1968 accounted for the major portion of the increase in marketed production. Deliveries to the United States increased by some 21 per cent as compared to an increase of 8 per cent in Canadian demand for Alberta gas.

At year end 1968 the years of supply of Alberta's natural gas, based on the 1968 marketed production, was approximately 40 years. As has been the trend over the last ten years, the number of years of supply continued to decline, but remains highly favourable in relation to that of the United States where known remaining gas reserves are equivalent to some 15 years of supply.

NATURAL GAS LIQUIDS

The term natural gas liquids embraces three products — pentanes plus, propane and butanes — which are produced in association with crude oil and natural gas. During 1968 the production of these products increased substantially, a continuation of the trend of the past few years.

Production of pentanes plus averaged 87,000 barrels per day in 1968. This product is similar to a light gravity crude oil and is used by refineries as a supplementary feedstock.

Compared to 1967, pentanes plus production in 1968 occupied a slightly reduced fraction of the refinery market, equivalent to some 12 per cent of the total production of crude oil. Remaining reserves of pentanes plus at the end of 1968 were over 934 million barrels, an increase of about 259 million barrels over the previous year. The Board's estimate of remaining reserves indicated a 29-year supply based on the 1968 production level, up sharply from the previous year.

Over the past few years an increasing share of the production of propane and butanes has been shipped to other Canadian provinces, the United States and Japan. During 1968 the share of production shipped to these areas maintained this same trend, rising to 76 per cent of the total. The estimated remaining reserves of propane and butanes totalled some 970 million barrels at the end of 1968, equivalent to 40 years of supply at the 1968 production rate.

SULPHUR

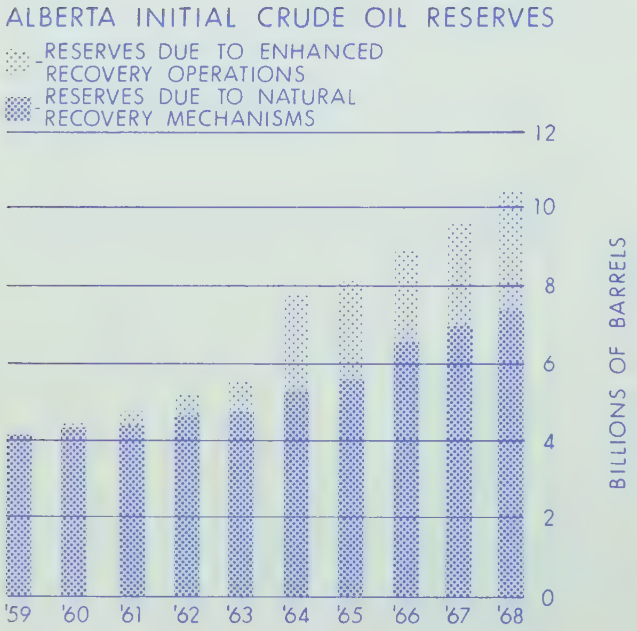
Sulphur is another by-product derived from the processing of raw gas. Over the past few years sales of sulphur have grown at a very high rate, due mainly to increasing world demand and a very favourable price structure.

In 1968 production of sulphur rose to 2.99 million long tons, substantially above the 1967 level, and growth in demand failed to match it, reaching 2.21 million long tons. Consequently, sulphur inventory levels increased substantially in 1968, a reversal of recent trends. Shipments of Alberta sulphur to Canadian and United States markets increased marginally over 1967, while the increases in offshore shipments went up by some 4 per cent. Based on the estimated 1968 year end remaining reserves of sulphur of some 140 million long tons, up sharply from 1967's 117 million, Alberta had about 47 years of supply at current levels of production.

ENHANCED RECOVERY OF CRUDE OIL

Enhanced recovery of oil is accomplished by augmenting the natural energy sources available in a given reservoir. This is usually accomplished by the injection to the oil producing zone of either water or gas, and the degree of improvement in oil recovery depends on the consistency (viscosity) of the oil and the flow channel properties of the reservoir rock.

The Board encourages the application of enhanced recovery techniques wherever the economics of doing so are favourable and, once a plan for enhanced recovery of oil has been put into operation, it periodically reviews the project's performance for recovery efficiency and continued technical suitability.



Some 25 enhanced recovery projects were initiated in Alberta oil pools in 1968, of which the following were of special interest. In Northwestern Alberta the Zama Field, which comprised 140 separate small pools at year end, together with the Rainbow area, received much of the Board's and the industry's attention, resulting in enhanced recovery operations by water injection in seven pools and by gas injection in four pools. In the Nipisi Pool, a large oil pool situated north of Lesser Slave Lake, horizontal displacement by water was started in 1968. This is expected to increase the total oil recovery of the pool by over 100 million barrels — the equivalent of finding another major oil pool.

As referred to under the heading "Conservation", the Board is now authorized to establish integrated schemes in the Province, providing for enhanced recovery operations and oil production in sequence from a group of pools.

An integrated scheme involving eight dome-shaped reef pools in the Rainbow Field was instigated in 1968. The eight pools have been credited with a total of 433 million barrels of recoverable oil. One of the pools will be subjected to a vertical upward displacement by water injection, another pool to vertical downward displacement by gas injection, and six pools will be sequentially subjected to a downward displacement solvent flood. The aggregate recoverable oil of the six solvent flood pools has been estimated to be 175 million barrels or 85 per cent of the oil in place, some 3.6 million barrels more oil recovery than would be possible by solvent flooding the same pools on a non-integrated basis. Future extension of solvent flood to the water injection pool and the gas injection pool may accomplish a further increase of 14 million barrels of recoverable reserves, all of which would be attributed to the integrated features of the scheme.

A similar, smaller integrated scheme in the Rainbow Field involves the solvent flooding of three pools and the gas flooding of one pool, with the incremental gains attributable to the integrated feature of the operation estimated to be about 450 thousand barrels.

As previously mentioned, the Rainbow-Zama area has been an area of intensive exploration leading to the discovery of over 250 pinnacle reef oil pools. Most of the pools are over 5000 feet below the surface and many of them are so small as to discourage the drilling of more than one well to each pool. Accurate estimation of the oil in place and recoverable reserves under primary depletion is therefore very difficult, especially until substantial amounts of production have been obtained. Also, the pools have generally been characterized by a relatively rapid decline in pool pressure when placed on production. This decline in pressure suggests the need for early consideration of enhanced recovery, but the dearth of data on the size, shape and reservoir rock characteristics of the pools has prompted further evaluation through experimental, or pilot, injection tests. A pilot injection test of from several months to one or two years duration may be used when the ultimate effectiveness of an enhanced recovery scheme is difficult to assess. During 1968 three vertical displacement water injection schemes, four vertical displacement water injection pilot tests, and four vertical displacement gas injection pilot tests were initiated in the Zama Field. As the nature of the oil accumulations in this area become better understood, many more enhanced recovery schemes are anticipated for the area.

Activity in Alberta's heavy oil deposits has been reduced over that evinced in the two or three preceding years. Thermal methods of enhanced recovery have been applied on an experimental basis to several oil sands deposits and heavy crude pools in the Province. During 1968 three such thermal schemes were operating in the Athabasca oil sands deposits, nine in the Cold Lake deposit, and one in each of the Lloydminster and Hughenden heavy crude oil pools.

Where oil sands deposits are sufficiently close to the surface to make feasible the strip mining of the bitumen, as is the case in the Great Canadian Oil Sands complex north of Fort McMurray, recovery efficiency can be quite high. During 1968, the Great Canadian plant did not attain its rated productive capacity, but as the operation stabilized the efficiency of the extraction and upgrading processes exceeded the design expectation. Production from the plant gradually increased during the year, reaching an average of almost 25,000 barrels per day during the last quarter.

CONSERVATION OF SOLUTION GAS

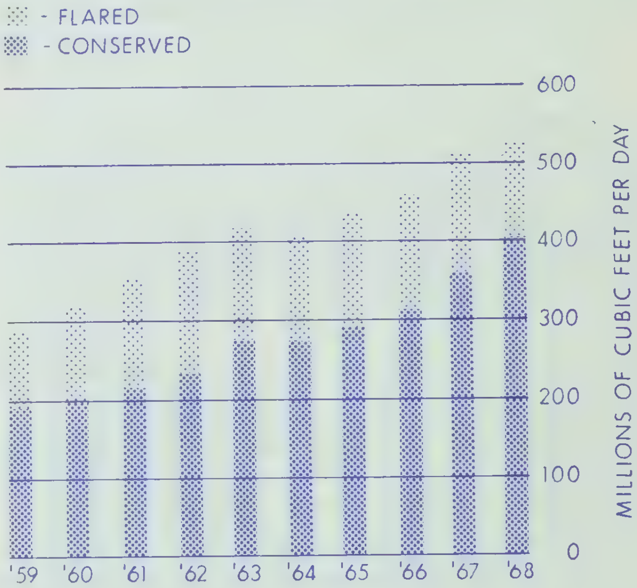
Crude oil as it exists in underground reservoirs is often under high pressures. In Alberta these pressures range up to 6000 pounds per square inch, and when the oil is brought to the surface and the pressure is reduced to atmospheric conditions, the gas dissolved in the oil is released. The volume of this solution gas varies from about 60 to 3000 cubic feet per barrel, depending largely on the pressure. In addition to solution gas, the oil in the reservoir may be overlain by a gas cap, and if the oil zone thickness is not great it may not be practical to produce the oil without also producing part of the gas from the gas cap. The production of both of these kinds of gas cannot be deferred without also deferring the oil production.

The Board is responsible for ensuring that gas produced unavoidably with oil is not wasted if it can be conserved economically. To determine if conservation of additional volumes of gas is feasible, the Board staff reviews regularly all producing oil pools in which the solution gas being produced is not fully conserved. When it appears gas conservation is feasible the Board meets with the operators to encourage them to undertake operations for gathering of the solution gas and has authority to restrict or prohibit the production of oil should such operations not be undertaken.

Where the solution gas contains substantial amounts of hydrogen sulphide the Board is concerned not only with the conservation of such gas but also with air pollution control. In these instances the Board increases its efforts to bring about gas conservation even though such conservation may be only marginally economic.

Some 190 billion cubic feet of gas was produced unavoidably with oil in Alberta in 1968. This represents 12 per cent of the gas produced in Alberta during the year. About 76 per cent of the unavoidable gas production was conserved as compared with 47 per cent in 1958 and 72 per cent in 1967. The portion flared during 1958 was high as the result of the flaring of gas production during the development period of the large Pembina Field. By 1959 Pembina solution gas was largely gathered and conserved. Typically, the percentage of solution gas conserved in the Province temporarily declines during the drilling-out stage of a large field as exemplified in the early 1960's during development of the Swan Hills area.

ALBERTA SOLUTION GAS PRODUCTION



Efforts toward conservation of solution gas continued during 1968. Gas conservation projects were begun in the Aerial, Clive, Lone Pine Creek, Rainbow, Simonette, Sturgeon Lake South and Sundre fields and extentions to existing projects, usually associated with extended pool limits were made in numerous other fields. At Simonette and Sturgeon Lake South a substantial part but not all of the solution gas has for some time been used for electric power generation. With the recent construction in the vicinity of a major gas transmission system, conservation of essentially all of the gas production is now feasible.

About two-thirds of the solution gas conserved in 1968 was processed for sale as marketable gas, liquid products and sulphur. The remainder was injected into underground reservoirs, either for storage or to increase the recovery of crude oil.

A feature of interest in some recent conservation schemes is an arrangement whereby all the gas and oil produced is transported in a mixed stream to central conditioning facilities where the oil is separated from the gas. In the past the practice has been to separate the gas from the oil at numerous batteries throughout a field and gather the gas and oil in separate pipe lines for delivery to processing facilities or major pipe line delivery points. The centralized separation and processing facilities have been made possible by improved understanding of the problems encountered when gas and oil move together in a pipe line. The use of large central processing facilities reduces unit operating costs and frequently makes feasible the conservation of even small volumes of vapours from storage tanks and processing vessels. They also provide a side benefit in the concurrent reduction of sour gas pollution effects. Such centralized facilities have been installed to accommodate much of the production from the Rainbow and Redwater fields and are planned or under construction for the Clive, Mitsue, Simonette and Sturgeon Lake South fields.

ALBERTA'S NEW PRORATION PLAN

Proration deals with the regulation of crude oil production to meet market requirements. In Alberta, proration has been confined to the light and medium gravity crude oils, these grades comprising the majority of the Province's crude oil reserves. The close correspondence between market requirements and productive capacity of heavy oils has made proration of them unnecessary. May 1, 1969 marks the full implementation of the Board's new proration plan — announced in 1964 — for the allocation of crude oil production. This article gives some background concerning prorationing in Alberta and some comments on the main features of the new plan.

Excess Capacity

Regulated market sharing was introduced in Alberta in the late 1930's, but became unnecessary during World War II due to greatly increased market demand. Province-wide proration of oil to market demand was again introduced in December 1950 following the development of excess oil productive capacity after the discovery of the Leduc-Woodbend, Redwater, Golden Spike, Acheson and other fields. Initially, the impact of excess capacity was regulated by the major oil purchasing companies, but this approach provoked dissatisfaction. At the request of industry, and after a hearing, the Board devised and has since administered a proration plan which assigns production allowables to the various pools and wells in the Province on a monthly basis to meet market requirements.

In the Board's first proration plan an oil well received an allowable based on two factors: an economic allowance, and the maximum permissive rate of production (MPR). The economic allowance was a fixed allowable, intended to permit a well owner to recover his capital and operating costs. The MPR was a measure of oil pool quality, reflecting the amount of oil recoverable from the pool, the recovery process and other producing characteristics. Each prorated well was entitled to produce its economic allowance and a stipulated fraction of the MPR. The latter depended upon the relationship of the level of demand and the Province's total capacity as defined by the MPR.

In 1957 modifications were made to the nature and level of the economic allowance, although its purpose remained unchanged. In addition, the proration formula was adjusted to give greater weight to the reserves of each pool.

New Plan

In 1963, recognizing that changed circumstances had affected the relationship between the economic allowance and the MPR, the Board held a full scale review of the operation of the proration scheme. In 1964 the Board published its decision outlining a new plan and in 1965 instituted a four-year transition period to terminate April 30, 1969. The objectives of the new plan included the distribution of production among and within pools in a reasonable and equitable manner; the prevention of waste; and the provision of incentives for the efficient operation of oil pools, to increase the amount of recoverable oil from a pool, and to assure continued production from all drilled pools which contain economically recoverable oil.

The new plan allocates production among pools in proportion to their crude oil reserves. The amounts so allocated are distributed to each well within a pool in proportion to the productive acreage attributed to the well, with modification where there is an enhanced recovery operation which increases the fraction of oil recovered from a reservoir. A well's allowable is not permitted to fall below the minimum allowance, which is scaled to well depth. However, this minimum allowance is different in concept to the previous "economic allowance" referred to beforehand in that it is restricted to producing wells and does not provide for the recovery of drilling costs, permitting only the recovery of completion and operating costs.

The PSU

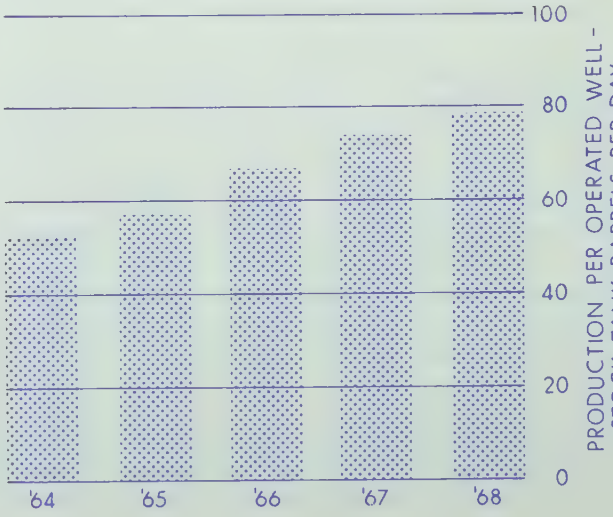
The Board's new plan also permits flexibility of spacing by allowing the formation of Production Spacing Units, to which a production allowable is allocated. A "PSU" will include lands attributed to shut-in wells or undrilled tracts, where it is reasonable to assume that the land is underlain by recoverable oil. Accordingly, allowables are allocated in proportion to acreage and wells need only be drilled to the extent required to prove up reserves and to provide the necessary productive capacity.

Savings

The extent to which oil well operators in the Province have availed themselves of the flexibility provided by the PSU concept is indicated by the fact that the average spacing of all oil producing wells has increased from about 90 acres in 1964 to some 120 acres in 1968. More significant is the average spacing in two large pools, Mitsue and Nipisi, developed in the Lesser Slave Lake region since the new PSU rules were adopted. The average area assigned to a well is about 530 acres in Mitsue and 420 acres in Nipisi, as compared to the standard spacing unit size of 160 acres. In these pools it is evident that drilling costs alone were only one-half to one-third of those which would have occurred under the old system. Such savings are not possible in all pools, especially the smaller ones, but some savings are realized.

The incentives for cost reduction through formation of PSU's have also affected the more productive older pools, encouraging the shutting in of excess wells with a consequent

AVERAGE WELL UTILIZATION
LIGHT AND MEDIUM CRUDE OIL



saving in operating costs. Although the volume of prorated oil production increased from 468,000 barrels per day in 1964 to 657,000 barrels per day in 1968, the number of wells operated has actually declined from 8970 to 8288 over the same period; or, expressed another way, the production per operated well has risen by 52 per cent over the same period. This trend is illustrated in the accompanying figure. Precise measurement of the overall degree of cost saving resulting from the provisions of the new plan is difficult, particularly for newly developing pools. However, there is an estimated annual saving of over 5 million dollars in the pools drilled under the old system.

Added Reserves

Since the distribution of production between pools under the new plan is based on the pool's crude oil reserves rather than the former basis of number of wells and reserves, the incentives to increase oil reserves by enhanced recovery schemes have been increased. Such schemes are an important factor in the growth of the Province's oil reserves and productivity. The increase in light and medium crude oil reserves attributable to enhanced recovery operations has been from 525 million barrels in 1962 to approximately 2.8 billion barrels in 1968. This amounts to 10 per cent and 28 per cent respectively of the total provincial reserves at those dates.

At the present time the productive capacity of Alberta's wells is about twice the market demand level. The necessity for the Board to continue to prorate oil production depends upon the future relationship between market growth and supply. If at some time in the future most of the Province's excess producing capacity is absorbed, the proration of oil production to market requirements will no longer be required.

OIL AND GAS STATISTICS

The collection, processing and publishing of statistics for oil, gas and other petroleum products is a Board responsibility that receives little general publicity but is one of prime importance. This is attested to by the very wide spread group of people who depend on the results. The Board's production accounting function is to supply data which serves as the basic raw material for both industry and the Board itself in solving a broad array of problems such as

(a) the most suitable means of producing oil and gas reservoirs,
(b) insuring that the rights of all owners in each oil or gas pool are properly protected,
(c) insuring compliance with Board and Government requirements regarding the prevention of pollution,
(d) analysing the demand for oil, gas, propane, butanes and sulphur, and
(e) forecasting requirements by suppliers, transporters, processors, etc.

The actual process of gathering and processing oil and gas statistics is carried out by the Board's Production Accounting Division. It makes use of an IBM 360/30 computer system operated by the Data Processing Department. Printing of the various Board statistical publications is arranged through the Reproduction Department.

Categories

The statistics processed by the Board can be divided into the following broad categories:

(a) production details for each producing well;
(b) the permitted production for each well and a comparison of it to actual production;
(c) production details for each processing plant;
(d) details of enhanced recovery schemes and water disposal operations;
(e) details of purchases and sale of oil, gas

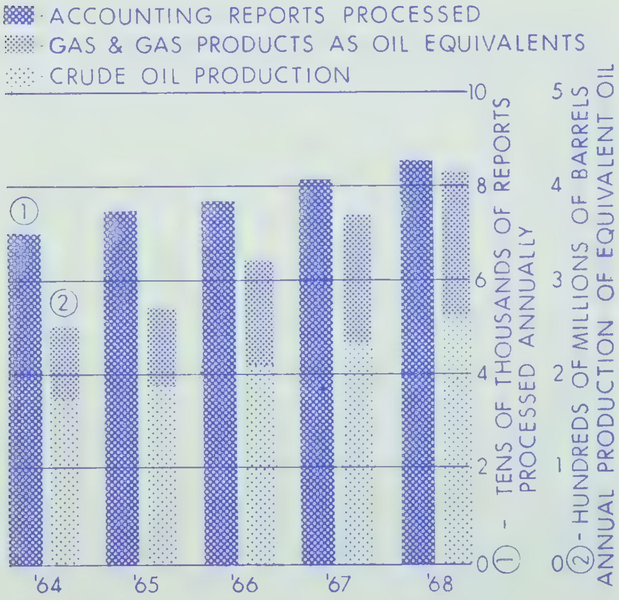
and plant products;
(f) details of volumes transported.

There has been a continual and rapid growth in the number of reports submitted to the Board. For example, some ten years ago the Board processed and published data for about 11,000 wells whereas by December 1968 this had increased to 18,300 wells.

Evolution

As the volume of production data for processing increased, the Board found it necessary to adopt more efficient techniques for digesting and publishing the data. A manual processing method that was effective in the late 1940's soon gave way to the use of book-keeping machines which in turn were replaced by punch cards and unit record equipment. The most recent step in this evolution has been the adoption of a sophisticated system utilizing an electronic computer and a data bank stored on magnetic disks and tapes.

NUMBER OF ACCOUNTING REPORTS PROCESSED ANNUALLY AS COMPARED TO TOTAL OIL AND GAS PRODUCTION



Complementing the adoption of modern data processing facilities is the development of arrangements with industry whereby production data is submitted to the Board in a form that will minimize the degree of processing required. Through co-operation with representatives of industry the Board has reached the point where some 65 per cent of the oil and gas production statistics received by the Board are provided on magnetic tape. This makes it possible to incorporate this data directly into the Board's records without the need of reprocessing, thus making substantial savings for both the industry and the Board.

The combination of efficiencies in processing systems and in the format of data submitted to the Board has made it possible to process the increased flow of statistics with little increase in the number of staff. A measure of the improvements made can be obtained by considering that in 1959 the Production Accounting Division processed 2,000 documents per employee whereas by 1968 this rate of processing had been increased to 3,300 equivalent documents.

Well Allowances

One of the major responsibilities in gathering and processing data relates to the production statistics for each producing well. The processing is particularly complex for oil wells since under the proration plan each well receives a certain allowable. It is necessary for the Board to ensure that operators comply with these allowable restrictions, and over the years a complex system of rules has been established. This is, of course, an area where computer facilities are particularly valuable. Not only must the data respecting production and allowables be determined, but it must also be conveyed to the operators so that they may take remedial action whenever it is required.

Products

One consequence of the rapid growth in the demand for Alberta oil and gas during the last decade has been an increasing volume of information related to the processing of the raw oil and gas. For example, the gas processing plant industry has undergone dramatic growth in the period — from 15 plants in 1958 to 104 plants in 1968 — and has created a need for marketing information related to plant products that was virtually non-existent a decade ago. To fill this and like needs, the Production Accounting Division provides in its publications detailed plant information, and comprehensive supply and disposition tables, for oil, gas, and gas plant products. This aspect of the Board's data processing and publishing work has been accomplished with negligible increase in the number of staff involved.

Liaison

The petroleum industry's growing sophistication has created the need for more reliable and detailed marketing information. Although the Board's own responsibilities determine the statistical data that must be gathered and processed, the Board has nevertheless attempted to accommodate this increasing need of industry for marketing data wherever it was reasonable. To do this the Board maintains close liaison with industry and interested government agencies. Meetings are held from time to time to review the format and utility of the Board's published statistics and also when necessary, to explore the need for the expansion or modification of the existing reporting statements.

Variety

The Board publishes its statistical reports in a wide variety of formats. They include production and disposition statistics of the oil and gas business on a weekly, monthly and annual basis. In another publication there is made available detailed well and pool production statistics on individual record cards suitable for permanent files. Also, well production data is made available to industry on magnetic tape in order that companies may use the data directly in their own computers rather than having first to prepare the magnetic tape.

SUMMARY OF BOARD OPERATIONS — 1968

ORGANIZATION AND STAFF

The three Board members, G. W. Govier, P. Eng., Chairman, A. F. Manyluk, P. Eng., Deputy Chairman, and V. Millard, Member, are appointed by the Lieutenant Governor in Council.

The Board's senior advisers are its Chief Engineer and its Solicitor. They provide technical and legal advice directly to the Board and when appointed for the purpose, they function as Acting Board Members. An Applications Advisory Group, under the chairmanship of the Chief Engineer and including the Board Solicitor and the Managers of the Gas, Oil and Development Departments, advises the Board on routine applications. In addition, the Managers of the engineering departments serve with other senior staff as examiners at public hearings. A list of the managers of all Board departments is provided on the back page of this report.

The Board has a staff of 268 with approximately 50 engineers and geologists. About 195 staff members are located in the Calgary head office with the balance being located in the Core Storage Center in Calgary, the Chemical Laboratory in Edmonton and the area offices in Edmonton, Drayton Valley, Red Deer, Black Diamond, and Medicine Hat.

The Oil and Gas Departments are primarily concerned with the maximum efficient recovery of oil and gas and related problems. The Development Department, with its Drilling and Production and Field Divisions, is responsible for the standards and the inspection of methods, technology, and equipment used in drilling and producing wells. Engineers and technicians in area offices inspect and report on operations in the field.

The Geology Department provides geological interpretations of oil and gas reservoirs. The Core Storage Center catalogues and retains samples of drill cuttings and cores and provides facilities for their examination by industry and the general public.

The Data Processing Department is responsible for computer programming and applications. An IBM System 360 computer provides a fully integrated, organization-wide data storage, retrieval and processing system.

IMPORTANT ACTIVITIES IN 1968

Two applications were considered for the removal of additional gas from the Province. Trans-Canada Pipe Lines Ltd. was granted permission to remove an additional 2.1 trillion cubic feet from the Province over a 25-year period, and the application of Alberta & Southern Gas Co. Ltd. to remove a further 1.27 trillion cubic feet was being considered at year end. The Board also granted an application from Dome Petroleum Limited to allow the removal of an additional 89 million barrels of propane from the Province over a 25-year period.

Gas conservation was initiated in the Aerial, Ante Creek, Lone Pine Creek and Rainbow Fields and present conservation schemes were extended in several other fields.

New gas processing schemes were approved for Brazeau, Ferrier, Judy Creek, Kaybob South, Marten Hills, Simonette and Tweedie. A plant to recover natural gas liquids from gas carried by the Foothills Division of Alberta Gas Trunk Line was approved for construction at Cochrane.

About 25 new enhanced recovery schemes were instituted during the year. The most noteworthy were two integrated schemes in the Rainbow Field which will use the limited supply of gas in the area to effect sequential miscible flooding of a number of crude oil pools.

An application by the Syncrude group for approval of an 80,000 barrel per day crude bitumen mining and extraction scheme in the oil sands was heard by the Board. Decision on the application was in effect deferred, with a provision to reconsider it in 1969.

Use of the Board's computer facilities expanded during 1968 and new equipment was added to handle the increasing work load. Some 14,000 individual jobs were processed through the computer centre. The Board continued its program of storage of major information systems on tape, with the completion of the core analysis and general well data storage and retrieval systems. Conversion of the market demand and allowables system to accommodate the final stage of the Board's new proration plan was also completed. Major technical applications developed during the year were: tabulation of reserves, gas gravity correlation and a generalized material balance program.

The drilling of recent discoveries continued at a rapid pace. In the Rainbow-Zama area the number of pools increased during the year by 100 to over 250. Recoverable oil reserves in this area now total some 1.1 billion barrels, about 10.5 per cent of the total reserves in the Province. Other active drilling areas were Kaybob South, Strachan-Ricinus and Hamilton Lake-Provost.

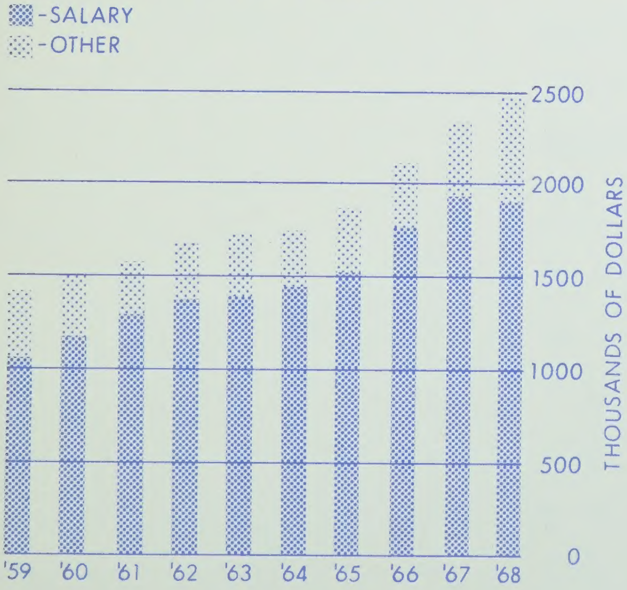
The Board continued to provide close surveillance of drilling in the busy Rainbow-Zama area. Special blow-out prevention regulations specified extra control equipment for drilling rigs in the area and included a procedure which rig crews must learn so they may contend with threatened blow-outs quickly before they develop into complete loss of well control.

Pollution prevention continued to receive major emphasis during the year. A program to reduce the volume of salt water stored in earthen pits was intensified. Air pollution from sour gas continued to produce a number of complaints. The Board and government departments involved in pollution problems were making arrangements at the year end for closer co-operation and a "team" approach to pollution investigations.

REVENUES AND EXPENDITURES

The revenues of the Board are provided by a direct grant, to meet 40 per cent of its net expenditures, from the Government of the Province of Alberta, and the levy of a tax on oil and gas properties in the Province for the remainder. Since the Government is taxed as the owner of Crown lands, the costs are borne about equally by industry and government.

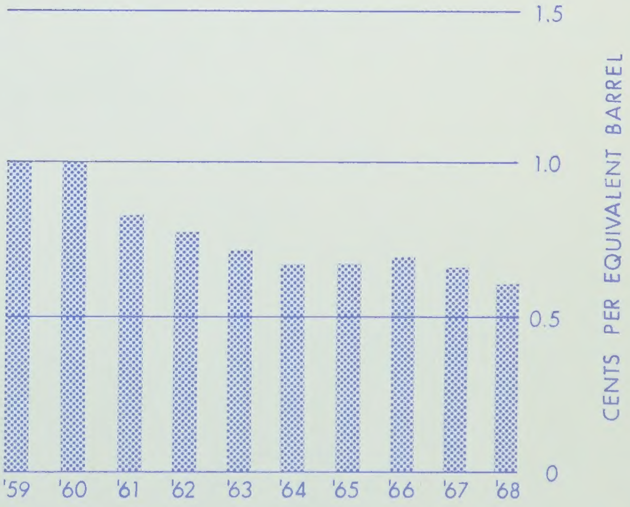
BOARD NET EXPENDITURES



In 1968, revenues were raised to meet a net expenditure of 2.5 million dollars after the receipt of some $289,000 from licence revenue and the sale of information.

The accompanying graphs show: (1) the level of Board net expenditures over the past ten years and the relationship of salary expenditure to the total expenditure after the deduction of miscellaneous revenue, and (2) the relationship of Board operations cost to production revenues in the Province by industry. This is done by reducing Board net expenditure to the number of cents per equivalent barrel* of crude oil production. During the last ten years this cost has been reduced from one cent to its present six-tenths of a cent.

BOARD NET EXPENDITURE PER EQUIVALENT BARREL OF CRUDE OIL PRODUCTION



BOARD MEMBERS

G. W. Govier	Chairman
A. F. Manyluk	Deputy Chairman
Vernon Millard	Member

SENIOR ADVISORS

D. R. Craig	Chief Engineer
N. A. Macleod	Solicitor

DEPARTMENT MANAGERS

V. E. Bohme	Development
G. J. DeSorcy	Gas
N. A. Strom	Oil
E. J. Morin	Data Processing
J. R. Pow	Geology
K. W. Fuller	Accounting
G. C. Watkins	Economics
R. F. Braun	Personnel
J. G. Anderson	Office Services

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